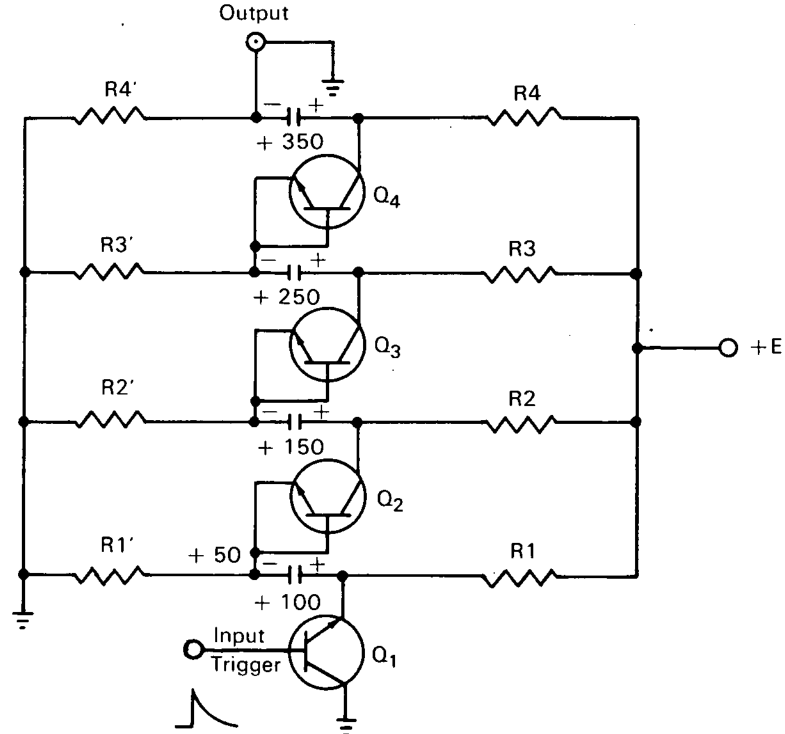
# AEC-NASA TECH BRIEF



## Transistorized Marx Bank Pulse Circuit Provides Voltage Multiplication with Nanosecond Rise-Time




### The problem:

To produce a highly reliable, 0 to 1 kilovolt, nanosecond rise-time instrumentation pulse circuit at high pulse repetition rates.

### The solution:

A base-triggered avalanche transistor circuit used in a Marx bank pulser configuration. The avalanche-mode transistors replace conventional spark gaps in the capacitor parallel-charging, series-discharging Marx bank.

The delay time from an input signal to the output is typically 6 nanoseconds. Pulse repetition rates of 10,000 pps are possible.

### How it's done:

The simplified circuit consists of a base-triggered transistor Q1 and diode-connected avalanche transistors Q2, Q3, and Q4. When Q1 avalanches, the emitter of Q2 goes from +50 V to −50 V, causing the collector–emitter voltage to change from 100 to 200 V. The over-volting causes Q2 to avalanche, and the output

(continued overleaf)

voltage across $R_L$ becomes the sum of the voltages across C1 and C2 minus the losses across Q1 and Q2. Similar operation occurs in all subsequent stages, with the delay for each stage becoming progressively less as over-volting increases. The voltage increase per stage is approximately 100 volts. For 10 stages the open circuit output pulse is about 1000 volts and the internal resistance of the device is about 150 ohms. Output pulse current should be limited to 5 amperes to prevent avalanche transistor failure.

**Notes:**

1. Typical rise-time for the circuit is 2 nsec.
2. Delay is minimized by quiescent threshold biasing, or idling, near the avalanche point. Delay per stage is negligible after approximately 3 stages, and large idling currents become unnecessary.
3. Average power dissipation depends upon pulse repetition frequency, the energy stored in the stage capacitor, the total capacity from collector to ground, and that due to the idling current.
4. The total power dissipated by the transistor may indicate the use of heat sinks in some circuit designs.
5. Additional details are contained in "A Solid State Nanosecond Pulser Using Marx Bank Techniques," by E. A. Jung and R. N. Lewis, *Nuclear Instruments and Methods,* 44 (1966).
6. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B68-10328

Source: E. A. Jung and R. N. Lewis
Electronics Division
(ARG-10110)

**Patent status:**

Inquiries about obtaining rights for the commercial use of this innovation may be made to:

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